IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Assignee: Xerox Corporation

Title: SPRING STRUCTURE WITH STRESS BALANCING LAYER

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APPEAL BRIEF

Sir:

This Appeal Brief, filed in triplicate, is in support of the Notice of Appeal dated October 30, 2003.

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I. REAL PARTY IN INTEREST

The real party in interest is the assignee, Xerox Corporation, pursuant to the Assignment recorded in the U.S. Patent and Trademark Office on October 12, 2001 on Reel 012274, Frame 0506.

II. RELATED APPEALS AND INTERFERENCES

Based on information and belief, there are no other appeals or interferences that could directly affect or be directly affected by or have a bearing on the decision by the Board of Patent Appeals in the pending appeal.

III. STATUS OF CLAIMS

Claims 1-19 are pending. Claims 1-9, 11-15 and 17-19 stand rejected, and Claims 10 and 16 are objected to as being dependent from a rejected base claim, but are otherwise indicated as being allowable.

In the present paper, rejected Clams 1-9, 11-15 and 17-19 are appealed.

Pending Claims 1-19 are listed in Appendix A.

IV. STATUS OF AMENDMENTS

All amendments have been entered.

V. SUMMARY OF THE INVENTION

Applicants' invention is directed to a spring structure of a type a spring metal finger an unlifted anchor portion attached to a substrate, and a released claw portion extending over the substrate. The spring metal finger is formed from a stress-engineered metal film (i.e., a metal film fabricated such that its lower portions have a higher internal compressive stress than its upper portions) that is at least partially formed on a release material layer. The present inventors recognized that most failures of spring structures (e.g., separation of the spring structure from an underlying substrate through delamination or peeling) occur a significant amount of time after fabrication, and believe these failures are caused at least in part by the internal stress gradient retained in the anchor portion of the spring metal finger. To counter the peeling effect produced by the internal stress gradient of the spring metal finger, Applicants' invention introduces a stress-balancing pad formed on the unlifted anchor portion of the spring metal finger, where the stress-balancing pad is formed with an internal stress gradient that is opposite in sign to the internal stress gradient of the spring metal finger. The opposite internal stress gradient is illustrated in Applicants' Fig. 4, which is reproduced below for reference, along with corresponding text from Applicants' specification (paragraph 0029, page 12):

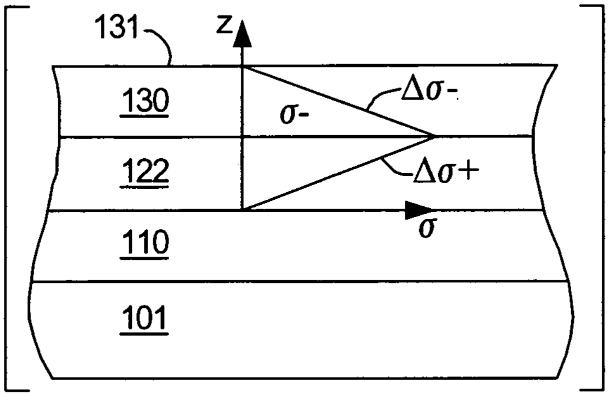

FIG. 4

Fig. 4 is partial side view in which internal stress gradients are superimposed over portions of anchor portion 122 and stress-balancing pad 130. As indicated in the lower portion of Fig. 4, anchor portion 122 is etched from a stress-engineered metal film that has a positive stress gradient $\Delta\sigma+$ (i.e., tending to bend the edges of anchor portion 122 away from substrate 101), whereas stress-balancing pad 130 is etched from a stress-engineered metal film that has a negative stress gradient $\Delta\sigma-$ (i.e., tending to bend the edges of stress-balancing pad 130 downward toward substrate 101).

The opposite internal stress gradient provided by the stress-balancing pad causes the stress-balancing pad to apply a downward force on the edges of the anchor portion of the spring metal finger, thereby resisting the delamination or peeling of the anchor portion that can result in separation from an underlying substrate.

According to an aspect of the present invention, the internal stress gradient (and moment) of the stress-balancing pad has a magnitude that is equal to or greater than the internal stress gradient (and moment) of the spring metal finger, thereby preventing delamination or peeling of the anchor portion by completely countering (nullifying) the internal stress (and moment) of the spring metal finger.

In accordance with another aspect of the present invention, the spring metal finger and the stress-balancing pad can be formed either from materials that have the same composition, or from materials that have different compositions. For example, both the spring metal finger and the stress-balancing pad can be formed from Mo or MoCr. The fabrication process is simplified when the same material is used for both layers because the number of targets in the

deposition equipment is minimized. In one embodiment, an etch stop layer (e.g., Cr or Ti) is provided between the spring metal finger and the stress-balancing pad to prevent undesirable etching of the spring metal finger during the fabrication process.

VI. ISSUES

The following issue is presented to the Board of Appeals for decision:

(A) Whether Claim 1 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(B) Whether Claim 2 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(C) Whether Claims 3-7 are anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(D) Whether Claims 8, 9, 11-15 and 17 are anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(E) Whether Claim 18 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(F) Whether Claim 19 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e).

VII. GROUPING OF THE CLAIMS

Claim 1 stands alone as Group 1.

Claim 2 stands alone as Group 2.

Claims 3-7 stand or fall together as Group 3.

Claims 8, 9, 11-15 and 17 stand or fall together as Group 4.

Claim 18 stands alone as Group 5.

Claim 19 stands alone as Group 6.

VIII. ARGUMENTS

As set forth below, the pending rejections of Claims 1-9, 11-15 and 17-19 over Fork are improperly raised under 35 U.S.C. 102(e) because Fork fails to teach every aspect of the claimed invention either explicitly or implicitly, and questions of obviousness are clearly present. Further, because the present application and Fork are owned by the same entity (Xerox Corp.), Fork is not a proper reference under 35 U.S.C. 103(c). Applicants strenuously object to the expense and loss of patent term caused by the Examiner's blatant attempt to circumvent the removal of Fork under 35 U.S.C. 103(c) by improperly maintaining the pending rejections under 35 U.S.C. 102(e).

A. Claim 1 is patentable under 35 U.S.C. 102(e) over Fork (USPAT 6,290,510)

Claim 1 recites (in pertinent part):

> ...a spring metal finger including an unlifted anchor portion attached to the substrate and a released claw portion extending over the substrate, wherein the anchor portion has a first internal stress gradient; and
>
> a stress-balancing pad formed on the anchor portion of the spring metal finger, wherein the stress-balancing pad has a second internal stress gradient that is opposite to the first internal stress gradient.

In rejecting Claim 1, the Examiner argues:

> Referring to claim 1, a spring structure comprising: a substrate, (Figure 3 #301); a spring metal finger, (Figure 3 #320), including an unlifted anchor portion, (Figure 3 #322), attached to the substrate, (Figure 3 #301), and a released claw portion, (Figure 3 #320), extending over the substrate, (Figure 3 #30 1), wherein the anchor portion, (Figure 3 #322), has a first internal stress gradient, (Col. 5 Lines 25-34); and a stress-balancing pad, (Figure 6 #638-1), formed on the anchor, (Figure 3 #322), portion of the spring metal finger, (Figure 3 #3 20), wherein the stress-balancing pad, (Figure 6 #638-1), has a second internal stress gradient, (Col. 9 Lines 62-63,

where the stress-balancing pad is secured to the substrate and has the opposite stress gradient than the spring metal finger, which the spring metal finger pulls away from the substrate and can be seen in Figure 6), that is opposite to the first internal stress gradient, (Col. 5 Lines 25-34).

The above quoted rejection is traversed for at least the following reasons:

First, the above-quoted rejection is improper in that it relies on portions of two different structures (e.g., the "substrate (Figure 3 #301)" and the "stress-balancing pad, (Figure 6 #638-1)". As indicated in the text copied below from Column 4 of Fork, these structures are clearly different in that Figs. 3(A) through 3(G) refer to a "first embodiment", and Figs. 6(A) through 6(H)) refer to a "third embodiment".

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FIGS. **3**(A) through **3**(G) are cross-sectional side views illustrating a method for fabricating a spring structure according to a first embodiment of the present invention;

according to a second embodiment of the present invention;

FIGS. **6**(A) through **6**(H) are cross-sectional side views illustrating a method for fabricating a spring structure according to a third embodiment of the present invention;

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As described in the embodiments provided below, self-alignment of the release material is beneficial both when the release material is electrically conductive, and when the release material is electrically non-conductive. Specifically, a first embodiment of the present invention utilizing a conductive release material is described below with reference to FIGS. 3(A) through 3(G), and a second embodiment of the present invention utilizing a non-conductive release material is described below with reference to FIGS. **5**(A) through **5**(G).

In addition, self-alignment can be achieved using several fabrication techniques. For example, a photoresist mask is utilized in the first and second embodiments (mentioned above) to etch both the spring metal and the release material. In a third embodiment, described with reference to FIGS. 6(A) through 6(H), this etching step is performed using plated metal as the spring metal mask.

Because the pending rejection relies on strutures from two separate embodiments, the rejection is clearly improper and should be withdrawn.

Second, as previously argued by Applicants, the pending rejection improperly mischaracterizes Fork's structure 638-1 as having a "second internal stress gradient". The common definition of "gradient" is a change in the value of a

quantity (e.g., temperature, pressure, or concentration) with change in a given variable and especially per unit distance in a specified direction. As used with reference to the present invention, the term "gradient" is related to a change in the internal stress with a change in film thickness. Referring again to Applicants' Fig. 4 (reproduced above), the positive internal stress gradient in anchor portion 122 increases from a minimum to a maximum value in the positive z-axis direction, and the negative internal stress gradient in stress-balancing pad 130 decreases from a maximum value to a minimum value in the positive z-axis direction. Applicants' specification further teaches that one method to generate these opposite internal stress gradients is to utilize fabrication parameters (e.g., deposition chamber pressure variations) that are altered in manner opposite to those used to form the spring metal layer/anchor portion:

> Spring metal finger 120 is etched from a stress-engineered metal film that is deposited by DC magnetron sputtering one or more metals using gas (e.g., Argon) pressure variations in the sputter environment during film growth. These pressure variations are controlled using known techniques to generate an internal stress gradient that causes claw 125 to bend away from substrate 101 when an underlying release material is removed. (Paragraph 0026, page 11, near top.)
>
> However, stress-balancing pad 130 is formed using a pressure variation sequence that is opposite to that utilized to generate spring metal finger 120, thereby causing stress-balancing pad 130 to include an internal stress that is opposite to that provided in spring metal finger 120. (Paragraph 0028, page 11, near bottom.)

In contrast, Fork teaches neither that plated metal portion 638-1 includes "an internal stress gradient", nor

that the "internal stress gradient" of plated metal portion 638-1 is opposite to the first internal stress gradient" provided in the anchor portion of the spring metal finger. As pointed out above, to generate "an internal stress gradient", a pressure variation sequence (or other stress varying procedure) must be utilized during the formation of plated metal portion 638-1. The text and figures of Fork that are relied upon by the Examiner fail to even remotely suggest either that plated metal portion 638-1 includes an internal stress gradient, or that a pressure variation sequence (or other stress varying procedure) is utilized in the formation of plated metal portion 638-1. Specifically, Fork's column 9, lines 62-63 (which are specifically relied upon by the Examiner) only mention the formation of plated metal portion 638-1 for improving electrical conductance:

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The resulting spring structure **600** is shown in FIG. 6(H). Note that some of passivation metal portion **630-1** (or plating metal if no passivation metal is used) is optionally retained on spring metal finger **620-1**F to improve electrical conduction and/or improve contact resistance. In addition, portions **638-1** of the plated metal are retained on all spring metal that remains secured to the substrate, thereby improving electrical conductance. Note also that the side edges of anchor portion **622** (and underlying release material portion **612**) are self-aligned to plated material portion **638-1**.

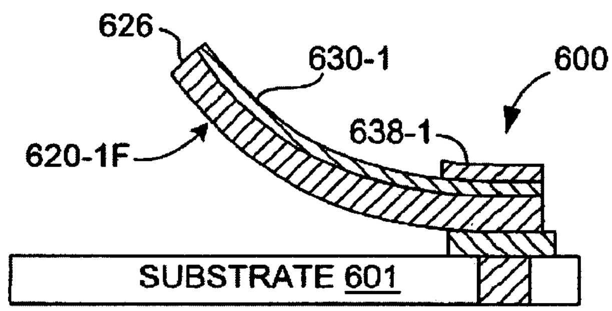

FIG 6(H)

Similarly, Fork's column 5, lines 25-34 merely discuss the formation of a spring metal layer 320, which corresponds to spring metal finger 620-1F of Fig. 6(H):

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FIG. 3(B) shows a spring metal layer **320** formed on release material layer **310** using know processing techniques such that it includes internal stress variations in the growth direction. For example, in one embodiment, spring metal layer **320** is formed such that its lowermost portions (i.e., adjacent to release material layer **310**) has a higher internal tensile stress than an upper portion of spring metal layer **320**, thereby causing spring metal layer **320** to have internal stress variations that cause a spring metal finger to bend upward away from substrate **301** (discussed below). Methods for generating such internal stress variations in spring metal layer **320** are taught, for example, in U.S. Pat. No. 3,842,189 (depositing two metals having different internal stresses) and U.S. Pat. No. 5,613,861 (e.g., single metal sputtered while varying process parameters), both of which being incorporated herein by reference. In one embodiment, which utilizes a 100 nm Ti release material layer, spring metal layer **320** includes MoCr sputter deposited to a thickness of 3 microns. In other embodiments, an Mo spring metal layer can be formed on Si or Ti release material layers.

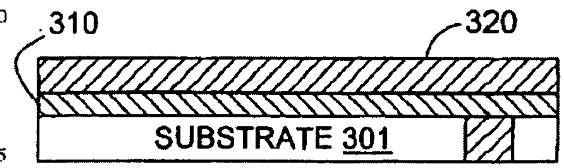

FIG 3(B)

The Final Office Action addressed Applicants' previous response by introducing a new basis for rejection that was not previously raised. The new argument is entered on page 2 of the pending Office Action, and is highlighted below:

> The Office Action filed in Paper No. 6 pointed out that the reference indicates that the metal spring consists of different gradients formed there in, (Fork et al. Col. 5 Lines *25-34)*, in which one of the gradients formed in the metal spring has a resulting vector away from the substrate. The Office Action also points out that the second gradient has a resulting vector the opposite of the first gradient, (Fork et al. Col. 9 Lines 62-63), in which the disclosure states the metal spring remains secure to the substrate. It is inherent by these disclosed statements in Fork et al. that the gradients would be the opposite otherwise the metal spring would pull away from the substrate, just as the first gradient area of the metal spring does as seen in Fork et al.'s Figure 3g. The 35 US.C 102(e) rejection will stand as is.

Applicant argued that the quoted text enclosed in the box (above) introduces new grounds for rejection because the

originally stated rejection of Claim 1 did not even remotely discuss the so-called "inherent" characteristics of plated metal portion 638-1. That is, as indicated above, the original rejection specifically argues that the plated metal portion 638-1 has a "second internal stress gradient". Applicants contend that the Examiner's reference to the "inherent" characteristics of plated metal portion 638-1 constitutes new grounds for rejection as directed to Claim 1, and as such the finality of the present Office Action is improper.

Even if the new rejection was properly entered in the Final Office Action, Applicants traverse the new rejection because the Examiner is clearly incorrect in his assertion that "the gradients would be the opposite otherwise the metal spring would pull away from the substrate". Applicants' specification clearly indicates, with reference to prior art structures, that the anchor portions of conventional spring metal fingers are secured to the underlying substrate, but that over time these connections can be weakened:

> A typical spring includes a spring metal finger having a flat anchor portion secured to a substrate, and a curved claw extending from the anchor portion and bending away from the substrate. (Paragraph 0002, page 1, mid-page.)
>
> The present inventors recognized that most failures of spring structures (e.g., separation of the spring structure from an underlying substrate through delamination or peeling) occur a significant amount of time after fabrication. The present inventors believe these failures are caused at least in part by the internal stress gradient retained in the anchor portion of the spring metal finger. That is, although the internal stress is essentially relieved in the claw of the spring metal finger upon release, the

> internal stress is retained in the anchor portion of the spring metal finger, along with other "trace" or unreleased portions of the spring metal layer. Over time, this retained internal stress is believed to bend the edges of the anchor portion upward (i.e., away from the underlying substrate), thereby causing delamination or peeling that weakens the attachment of the spring metal finger to the substrate. (Paragraph 3, page 2.)

The above-quoted text clearly indicates that prior art spring structures remained connected to an underlying substrate without the use of a stress-balancing pad. What this passage expresses, in other words, is that peeling does not occur until the stresses concentrated at the interfaces of the anchor portion can overcome the adhesion of the release layer to the substrate and/or spring. Within a regime of limited spring stiffness and compression, the adhesion is large enough to resist such stresses. It is fallacious to conclude that the anchor would pull away from the substrate without stress balancing layers, because this conclusion ignores the presence of interface adhesion. Stress balancing layers simply extend the regime of stiffness and compression that may be achieved.

Moreover, Fork in fact teaches away from the Examiner's apparent argument that a stress balancing layer is necessary in that Fork discloses spring structures that do not include the plated metal portion 638-1 (e.g., see Fork's Fig. 3(G) (reproduced below for reference):

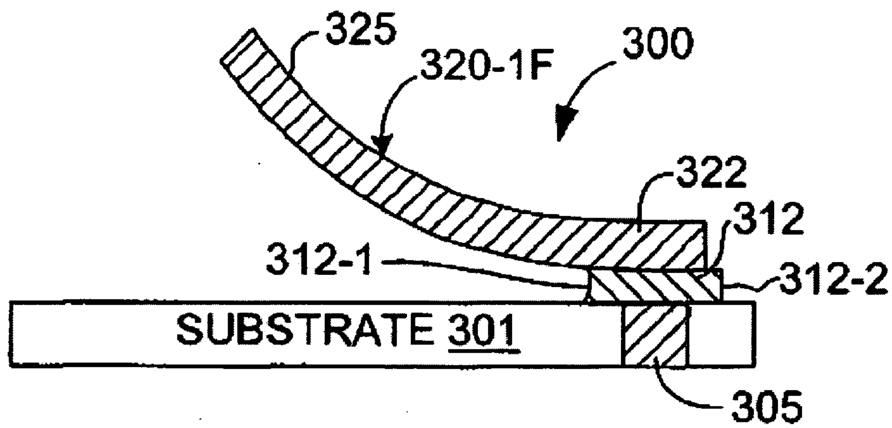

FIG 3(G)

Accordingly, the Examiner's assertion that it "is inherent by these disclosed statements in Fork et al. that the gradients would be the opposite otherwise the metal spring would pull away from the substrate" is not supported by Fork, and therefore should be withdrawn.

For at least the above reasons, Applicants contend that the rejection of Claim 1 is improper and should be withdrawn.

B. <u>Claim 2 is patentable under 35 U.S.C. 102(e) over Fork</u>

Claim 2 is dependent from Claim 1, and is therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 1.

In addition, Claim 2 further recites:

> ...wherein the second internal stress gradient of the stress-balancing pad is equal in magnitude to or greater in magnitude than the first internal stress gradient of the anchor portion.

In rejecting Claim 2, the Examiner writes:

> Referring to claim 2, a spring structure, wherein the second internal stress gradient of the stress-balancing pad is equal in magnitude to or greater in magnitude, (Col. 9 Lines 62-63, where the stress-balancing pad is secured to the

> substrate and has the opposite stress gradient than the spring metal finger and it is apparent that the magnitude of the stress gradient for the stress balancing pad is equal or greater than the first internal gradient because the spring metal finger would peel away from the substrate if it was less than; this can be seen in Figure 6), than the first internal stress gradient of the anchor portion, (Col. 5 Lines 25-34).

Applicants traverse the rejection of Claim 2 for reasons similar to those directed to the "new grounds of rejection" discussed above with reference to Claim 1. In particular, Applicants' specification clearly indicates, with reference to prior art structures, that the anchor portions of conventional spring metal fingers are secured to the underlying substrate, but that over time these connections can be weakened (see paragraphs 0002 and 0003 of Applicants' specification, reproduced above). What this text expresses is that peeling does not occur until the stresses concentrated at the interfaces of the anchor portion.can overcome the adhesion of the release layer to the substrate and/or spring. Within a regime of limited spring stiffness and compression, the adhesion is large enough to resist such stresses. It is fallacious to conclude that the anchor would pull away from the substrate without stress balancing layers, because this conclusion ignores the presence of interface adhesion. Stress balancing layers simply extend the regime of stiffness and compression that may be achieved. Moreover, as set forth above in additional detail, Fork in fact teaches away from the Examiner's apparent argument that a stress balancing layer is necessary in that Fork discloses spring structures that do not include the plated metal portion 638-1 (e.g., see Fork's Fig. 3(G)). For at least the above reasons, the Examiner's assertion that it "it is apparent that the magnitude of the stress gradient for the stress balancing pad is equal or greater than the first internal

gradient because the spring metal finger would peel away from the substrate if it was less than" is not supported by Fork.

For at least the above reasons, Applicants contend that the rejection of Claim 1 is improper and should be withdrawn.

C. <u>Claims 3-7 are patentable under 35 U.S.C. 102(e) over Fork</u>

<u>Claim 3</u>

Claim 3 is also dependent from Claim 1, and is therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 1.

In addition, Claim 3 further recites:

> ...wherein both the spring metal finger and the stress-balancing pad consist essentially of a single material composition.

In rejecting Claim 3 the Examiner writes:

> Referring to claim 3, a spring structure, wherein both the spring metal finger and the stress-balancing pad, (Figure 6 #638-1), consist essentially of a single material composition, (Col. 5 Line 42 states the spring metal finger #320 can be made of MoCr and Col. 10 Line 8 states the stress balancing pad #638-1 can be made of MoCr).

Applicants traverse the rejection directed to Claim 3 in that it mischaracterizes the teachings of Fork's Column 10, line 8. The Examiner argues "Col. 10 Line 8 states the stress balancing pad #638-1 can be made of MoCr". As clearly set forth in Col. 9, lines 11-38 and 47-67 (reproduced below), the "stress metal layer" referred to Col. 10, line 8 (also shown) is stress metal layer 620, NOT plated layer 638:

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The fabrication method according to the third embodiment begins in a manner similar to the first and second embodiments (discussed above) in that a release material layer **610** is formed over a substrate **601** that includes a contact pad **605** (FIG. 6(A)), and then a spring metal layer **620** is formed on release material layer **610** (FIG. 6(B)). Release material layer **610** can be conductive, as described above with reference to the first embodiment, or non-conductive, as described above with reference to the second embodiment. The present example depicts the use of conductive release materials are used—if non-conductive release materials are used, a metal strap must be included that is formed in the manner described above with reference to FIGS. 5(D) and 5(E).

Plated metal is then patterned on spring metal layer **620** as follows. First, an optional passivation metal layer **630** is deposited on spring metal layer **620** (FIG. 6(C)). Passivation metal layer **630** (e.g., Au, Pt, Pd, or Rh) is provided as a seed material for the subsequent plating process if spring metal layer **620** does not serve as a good base metal. Passivation metal layer **630** may also be provided to improve contact resistance in the completed spring structure. Next, a resist pattern (mask) **635** is formed over spring metal layer **620** (i.e., on passivation metal layer **630**, if used) that has an opening **636** whose edge **637** is in the shape of the spring metal island to be formed (FIG. 6(D)). A plated metal pattern **638**, such as nickel, is then formed using a known plating process through opening **636** on the exposed portion of passivation metal layer **630** (FIG. 6(E)). Plated metal structure **638** may comprise more than one type of metal. The plating process can be electroless, but is preferably electroplating, using the previously deposited metal (i.e., passivation metal layer **630** and/or spring metal layer **620**) as the cathode. Resist pattern **635** is then removed.

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Referring to FIG. 6(G), once etching is completed, a release mask **650** is applied in the manner described in the above embodiments. During the subsequent release etch, all or part of plated metal structure **638** exposed within the release window is selectively etched using a suitable etchant **660-A** that does not remove free portion **622** of spring metal island **620-1**. Release material portion **615** is also removed using an etchant **660-B**, which either can be the same as or different from etchant **660-A**. If desired, the release window can then be stripped, or may be retained as passivation. The latter may be preferred if it is a material such as polyimide.

The resulting spring structure **600** is shown in FIG. 6(H). Note that some of passivation metal portion **630-1** (or plating metal if no passivation metal is used) is optionally retained on spring metal finger **620-1F** to improve electrical conduction and/or improve contact resistance. In addition, portions **638-1** of the plated metal are retained on all spring metal that remains secured to the substrate, thereby improving electrical conductance. Note also that the side edges of anchor portion **622** (and underlying release material portion **612**) are self-aligned to plated material portion **638-1**.

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The choice of plating material is dependent on its selective etchability compared to spring metal island. However, because the thickness of the plated metal pattern (a few microns) would be much greater compared to the spring metal layer (less than 2 microns), any etching that might occur on the plated metal pattern would be negligible. An example that is possible using selective etchants is a plated Ni pattern on a Au/MoCr/Ti spring metal layer. In this embodiment, examples of wet etchants that can be used are: NaOH-KFCN for the MoCr, KI for the Au, HF for the Ti, and HCl for the final removal of the Ni.

In particular, the text of Col. 9 provided above clearly teaches the formation of a stress metal layer 620, a passivation layer 630 formed over stress metal layer 620, and then plated metal pattern 638, which is subsequently etched to form plated metal portion 638-1. Note that Col. 10, lines 1-8 refer to the plating material and associated etchant, and specifically to an etchant for etching Ni formed on "a Au/MoCr/Ti spring metal layer". Accordingly, the Examiner's contention that plated metal portion 638-1 is formed from MoCr is clearly not supported by the cited passage from Fork.

Accordingly, the specific rejections directed to Claim 3 is improper and should be withdrawn.

Claims 4-7

Claims 4-7 are dependent from Claim 3, and are therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 3.

In addition, the rejections of Claim 5-7 are further traversed in that they relies on a rejection under 35 U.S.C. 112 that is no longer pending. For example, the pending rejection of Claim 5 is as follows:

> 8. Referring to claim 5, a spring structure, further comprising an etch stop layer formed between the anchor portion of the spring metal finger and the stress-balancing pad, (See 112 rejection above).

Applicant respectfully points out that there is no pending rejection under 35 U.S.C. 112. Similar references to the non-existent rejection under 35 U.S.C. 112 are referenced in the specific rejections directed to Claims 6 and 7. As such, the rejections of Claims 5-7 are clearly improper and must be withdrawn.

For at least the above reasons, Applicants contend that the rejections of Claims 3-7 are improper and should be withdrawn.

D. Claims 8, 9, 11-15 are patentable under 35 U.S.C. 102(e) over Fork

Claims 8, 9, 11-15 and 17 are dependent from Claim 1, and are therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 1.

In addition, Applicants traverse the rejections of Claims 9 and 13-15 for reasons similar to those provided

above with reference to Claim 3. In particular, Col. 9, lines 11-38 and 47-67 (reproduced above) clearly teach that the "stress metal layer" referred to Col. 10, line 8 is stress metal layer 620, NOT plated layer 638. As such, the Examiner's contention that plated metal portion 638-1 is formed from MoCr is clearly not supported by Fork's Col. 10, line 8. Accordingly, the specific rejections directed to Claims 9 and 13-15 are improper and should be withdrawn.

E. Claims 18 is patentable under 35 U.S.C. 102(e) over Fork

Similar to Claim 1, Claim 18 recites (in pertinent part):

> ...a spring metal finger having an anchor portion supported by the substrate and a claw portion extending over the substrate; and
>
> a stress-balancing pad formed over the anchor portion of the spring metal finger,
>
> wherein the spring metal finger is formed from a first stress-engineered material having a first internal stress moment that causes the claw portion to bend away from the substrate, and
>
> wherein the stress-balancing pad is formed from a second stress-engineered material having a second internal moment that opposes to the first internal stress moment.

In rejecting Claim 18, the Examiner argues (in part):

> ...wherein the spring metal finger, (Figure 6 #620), is formed from a first stress-engineered material having a first internal stress moment that causes the claw portion to bend away from the substrate, (Figure 6 #60 1), and wherein the stress-balancing pad is formed from a second stress-engineered material having a second internal moment that opposes to the first internal stress moment, (Col. 9 Lines 62-63, where the stress-balancing pad is secured to the

> substrate and has the opposite stress gradient than the spring metal finger, which the spring metal finger pulls away from the substrate and can be seen in Figure 6).

The above-quoted rejection is traversed for reasons similar to those provided above with reference to Claim 1. In particular, the rejection is traversed in that Fork teaches neither that plated metal portion 638-1 includes "a second internal momement", nor that the "second internal moment" of plated metal portion 638-1 is opposed to the "first internal stress moment" of the spring metal finger. Similar to the arguments related to internal stress gradients, to generate "an internal moment", a pressure variation sequence (or other stress varying procedure) must be utilized during the formation of plated metal portion 638-1. The text and figures of Fork that are relied upon by the Examiner fail to even remotely suggest either that plated metal portion 638-1 includes an internal moment, or that a pressure variation sequence (or other stress varying procedure) is utilized in the formation of plated metal portion 638-1. Accordingly, the rejection of Claim 18 under 35 U.S.C. 102(e) is improper and should be withdrawn.

F. <u>Claims 19 is patentable under 35 U.S.C. 102(e) over Fork</u>

Claim 19 is also dependent from Claim 18, and is therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 18.

In addition, similar to Claim 2, Claim 19 further recites:

> ...wherein the first internal stress moment of the anchor portion has a first magnitude, and
>
> wherein the second internal stress moment of the stress-balancing pad has a second magnitude that is equal to or greater than the first magnitude.

Accordingly, for reasons similar to those provided above with reference to Claim 2, Claim 19 is further distinguished over Fork, and the rejection of Claim 19 should be withdraw.

IX. CONCLUSION

For the foregoing reasons, it is submitted that the Examiner's rejections of Claims 1-19 are erroneous, and reversal of these rejections is respectfully requested.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Services as First Class Mail in an envelope addressed to: Mail Stop Appeal Brief-Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA, 22313-1450.

Patrick T. Bever

Attorney for Appellant

Dec. 29, 2003

Date of Signature

X. APPENDIX A

1. A spring structure comprising:

a substrate;

a spring metal finger including an unlifted anchor portion attached to the substrate and a released claw portion extending over the substrate, wherein the anchor portion has a first internal stress gradient; and

a stress-balancing pad formed on the anchor portion of the spring metal finger, wherein the stress-balancing pad has a second internal stress gradient that is opposite to the first internal stress gradient.

2. The spring structure according to Claim 1, wherein the second internal stress gradient of the stress-balancing pad is equal in magnitude to or greater in magnitude than the first internal stress gradient of the anchor portion.

3. The spring structure according to Claim 1, wherein both the spring metal finger and the stress-balancing pad consist essentially of a single material composition.

4. The spring structure according to Claim 3, wherein the single material composition is one of Molybdenum (Mo) and Molybdenum-Chromium (MoCr).

5. The spring structure according to Claim 3, further comprising an etch stop layer formed between the anchor portion of the spring metal finger and the stress-balancing pad.

6. The spring structure according to Claim 5, wherein both the spring metal finger and the stress-balancing pad

consist essentially of Molybdenum (Mo), and wherein the etch stop layer comprises Chromium (Cr).

7. The spring structure according to Claim 5, wherein both the spring metal finger and the stress-balancing pad consist essentially of Molybdenum-Chromium (MoCr), and wherein the etch stop layer comprises Titanium (Ti).

8. The spring structure according to Claim 1, wherein the spring metal finger comprises a first material, and wherein the stress-balancing pad comprises a second material that is different from the first material.

9. The spring structure according to Claim 8, wherein the first material consists essentially of a Molybdenum-Chromium alloy (MoCr), and wherein the stress-balancing pad consists essentially of Molybdenum (Mo).

10. The spring structure according to Claim 8, wherein the first material consists essentially of Nickel-Zirconium (NiZr), and wherein the second material consists essentially of Titanium that is solution hardened with Silicon (Ti:Si).

11. The spring structure according to Claim 1, further comprising a support pad formed between the substrate and the anchor portion of the spring metal finger.

12. The spring structure according to Claim 11, wherein the support pad comprises one of Titanium (Ti) and Silicon (Si).

13. The spring structure according to Claim 11, wherein the support pad comprises Ti, wherein both the spring metal

finger and the stress-balance portion comprise Molybdenum (Mo), and wherein the spring structure further comprises an etch stop layer consisting of Chromium (Cr) that is formed between the spring metal finger and the stress-balance portion.

14. The spring structure according to Claim 11, wherein the support pad comprises Si, wherein both the spring metal finger and the stress-balance portion comprise Molybdenum-Chromium (MoCr), and wherein the spring structure further comprises an etch stop layer consisting of Titanium (Ti) formed between the spring metal finger and the stress-balance portion.

15. The spring structure according to Claim 11, wherein the support pad comprises Titanium (Ti), wherein the spring metal finger comprises Molybdenum-Chromium (MoCr), and wherein the stress-balance portion comprise Molybdenum (Mo).

16. The spring structure according to Claim 11, wherein the support pad comprises Ti, wherein the spring metal finger comprises Nickel-Zirconium (NiZr), and wherein the stress-balance portion comprises Titanium that is solution hardened with Silicon (Ti:Si).

17. The spring structure according to Claim 11, further comprising a conductor formed on the substrate,

wherein the support pad comprises an electrically conductive material, and

wherein the spring metal finger is electrically connected to the conductor via the support pad.

18. A spring structure comprising:

a substrate;

a spring metal finger having an anchor portion supported by the substrate and a claw portion extending over the substrate; and

a stress-balancing pad formed over the anchor portion of the spring metal finger,

wherein the spring metal finger is formed from a first stress-engineered material having a first internal stress moment that causes the claw portion to bend away from the substrate, and

wherein the stress-balancing pad is formed from a second stress-engineered material having a second internal moment that opposes to the first internal stress moment.

19. The spring structure according to Claim 18,

wherein the first internal stress moment of the anchor portion has a first magnitude, and

wherein the second internal stress moment of the stress-balancing pad has a second magnitude that is equal to or greater than the first magnitude.

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PTO/SB/17 (05-03)
Approved for use through 04/30/2003. OMV 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

FEE TRANSMITTAL for FY 2003

Effective 01/01/2003. Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 C.F.R. § 1.27

TOTAL AMOUNT OF PAYMENT ($) 330.00

Complete if Known	
Application Number	09/976,394
Filing Date	10/12/2001
First Named Inventor	Linda T. Romano
Examiner Name	V.A. Mandala
Art Unit	2826
Attorney Docket Number	A0729 (XC-009)

METHOD OF PAYMENT (check one)

1. ☒ The Director is authorized to charge indicated fees and credit any over payments to:

Deposit Acct. No. 24-0037 (Docket No. A0729)

Deposit Acct Name Bever, Hoffman & Harms, LLP

☒ **Charge Any Additional Fee Required Under 37 CFR § 1.16 & 1.17**

2. ☐ **Payment Enclosed:**

☐ Check ☐ Credit Card ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	

SUBTOTAL (1) ($)

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee from below		Fee Paid
Total Claims		-20** =		x		=	
Independent Claims		-3** =		x		=	
Multiple Dependent						=	

***or number previously paid, if greater; For Reissues, see below*

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	**Reissue independent claims over original patent
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($)

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	330.00
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Petitions related to provisional applications	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (Specify) ______

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 330.00

SUBMITTED BY				Complete *(if applicable)*	
Name *(Print/Type)*	Patrick T. Bever	Registration No. *(Attorney/Agent)*	33,834	*Telephone*	(408) 451-5902
Signature	Patrick T. Bever			*Date*	**12/29/2003**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Linda T. Romano and David Kirtland Fork

Assignee: Xerox Corporation

Title: SPRING STRUCTURE WITH STRESS BALANCING LAYER

Serial No.: 09/976,394-2792 File Date: October 12, 2001

Examiner: V. A. Mandala Art Unit: 2826

Atty. Dkt. No.: A0729 (XC-009)

Date: December 29, 2003

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COMMISSIONER OF PATENTS AND TRADEMARKS
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

This Appeal Brief, filed in triplicate, is in support of the Notice of Appeal dated October 30, 2003.

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E. Claim 18 is patentable under 35 U.S.C. 103(a) over Fork 19

F. Claim 19 is patentable under 35 U.S.C. 103(a) over Fork 20

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I. REAL PARTY IN INTEREST

The real party in interest is the assignee, Xerox Corporation, pursuant to the Assignment recorded in the U.S. Patent and Trademark Office on October 12, 2001 on Reel 012274, Frame 0506.

II. RELATED APPEALS AND INTERFERENCES

Based on information and belief, there are no other appeals or interferences that could directly affect or be directly affected by or have a bearing on the decision by the Board of Patent Appeals in the pending appeal.

III. STATUS OF CLAIMS

Claims 1-19 are pending. Claims 1-9, 11-15 and 17-19 stand rejected, and Claims 10 and 16 are objected to as being dependent from a rejected base claim, but are otherwise indicated as being allowable.

In the present paper, rejected Clams 1-9, 11-15 and 17-19 are appealed.

Pending Claims 1-19 are listed in Appendix A.

IV. STATUS OF AMENDMENTS

All amendments have been entered.

V. SUMMARY OF THE INVENTION

Applicants' invention is directed to a spring structure of a type a spring metal finger an unlifted anchor portion attached to a substrate, and a released claw portion extending over the substrate. The spring metal finger is formed from a stress-engineered metal film (i.e., a metal film fabricated such that its lower portions have a higher internal compressive stress than its upper portions) that is at least partially formed on a release material layer. The present inventors recognized that most failures of spring structures (e.g., separation of the spring structure from an underlying substrate through delamination or peeling) occur a significant amount of time after fabrication, and believe these failures are caused at least in part by the internal stress gradient retained in the anchor portion of the spring metal finger. To counter the peeling effect produced by the internal stress gradient of the spring metal finger, Applicants' invention introduces a stress-balancing pad formed on the unlifted anchor portion of the spring metal finger, where the stress-balancing pad is formed with an internal stress gradient that is opposite in sign to the internal stress gradient of the spring metal finger. The opposite internal stress gradient is illustrated in Applicants' Fig. 4, which is reproduced below for reference, along with corresponding text from Applicants' specification (paragraph 0029, page 12):

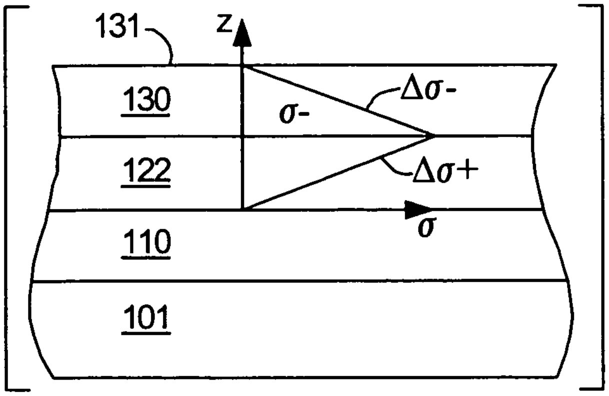

FIG. 4

Fig. 4 is partial side view in which internal stress gradients are superimposed over portions of anchor portion 122 and stress-balancing pad 130. As indicated in the lower portion of Fig. 4, anchor portion 122 is etched from a stress-engineered metal film that has a positive stress gradient $\Delta\sigma+$ (i.e., tending to bend the edges of anchor portion 122 away from substrate 101), whereas stress-balancing pad 130 is etched from a stress-engineered metal film that has a negative stress gradient $\Delta\sigma-$ (i.e., tending to bend the edges of stress-balancing pad 130 downward toward substrate 101).

The opposite internal stress gradient provided by the stress-balancing pad causes the stress-balancing pad to apply a downward force on the edges of the anchor portion of the spring metal finger, thereby resisting the delamination or peeling of the anchor portion that can result in separation from an underlying substrate.

According to an aspect of the present invention, the internal stress gradient (and moment) of the stress-balancing pad has a magnitude that is equal to or greater than the internal stress gradient (and moment) of the spring metal finger, thereby preventing delamination or peeling of the anchor portion by completely countering (nullifying) the internal stress (and moment) of the spring metal finger.

In accordance with another aspect of the present invention, the spring metal finger and the stress-balancing pad can be formed either from materials that have the same composition, or from materials that have different compositions. For example, both the spring metal finger and the stress-balancing pad can be formed from Mo or MoCr. The fabrication process is simplified when the same material is used for both layers because the number of targets in the

deposition equipment is minimized. In one embodiment, an etch stop layer (e.g., Cr or Ti) is provided between the spring metal finger and the stress-balancing pad to prevent undesirable etching of the spring metal finger during the fabrication process.

VI. ISSUES

The following issue is presented to the Board of Appeals for decision:

(A) Whether Claim 1 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(B) Whether Claim 2 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(C) Whether Claims 3-7 are anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(D) Whether Claims 8, 9, 11-15 and 17 are anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(E) Whether Claim 18 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e);

(F) Whether Claim 19 is anticipated by Fork (USP 6,290,510) under 35 U.S.C. 102(e).

VII. GROUPING OF THE CLAIMS

Claim 1 stands alone as Group 1.

Claim 2 stands alone as Group 2.

Claims 3-7 stand or fall together as Group 3.

Claims 8, 9, 11-15 and 17 stand or fall together as Group 4.

Claim 18 stands alone as Group 5.

Claim 19 stands alone as Group 6.

VIII. ARGUMENTS

As set forth below, the pending rejections of Claims 1-9, 11-15 and 17-19 over Fork are improperly raised under 35 U.S.C. 102(e) because Fork fails to teach every aspect of the claimed invention either explicitly or implicitly, and questions of obviousness are clearly present. Further, because the present application and Fork are owned by the same entity (Xerox Corp.), Fork is not a proper reference under 35 U.S.C. 103(c). Applicants strenuously object to the expense and loss of patent term caused by the Examiner's blatant attempt to circumvent the removal of Fork under 35 U.S.C. 103(c) by improperly maintaining the pending rejections under 35 U.S.C. 102(e).

A. Claim 1 is patentable under 35 U.S.C. 102(e) over Fork (USPAT 6,290,510)

Claim 1 recites (in pertinent part):

> ...a spring metal finger including an unlifted anchor portion attached to the substrate and a released claw portion extending over the substrate, wherein the anchor portion has a first internal stress gradient; and
>
> a stress-balancing pad formed on the anchor portion of the spring metal finger, wherein the stress-balancing pad has a second internal stress gradient that is opposite to the first internal stress gradient.

In rejecting Claim 1, the Examiner argues:

> Referring to claim 1, a spring structure comprising: a substrate, (Figure 3 #301); a spring metal finger, (Figure 3 #320), including an unlifted anchor portion, (Figure 3 #322), attached to the substrate, (Figure 3 #301), and a released claw portion, (Figure 3 #320), extending over the substrate, (Figure 3 #30 1), wherein the anchor portion, (Figure 3 #322), has a first internal stress gradient, (Col. 5 Lines 25-34); and a stress-balancing pad, (Figure 6 #638-1), formed on the anchor, (Figure 3 #322), portion of the spring metal finger, (Figure 3 #3 20), wherein the stress-balancing pad, (Figure 6 #638-1), has a second internal stress gradient, (Col. 9 Lines 62-63,

where the stress-balancing pad is secured to the substrate and has the opposite stress gradient than the spring metal finger, which the spring metal finger pulls away from the substrate and can be seen in Figure 6), that is opposite to the first internal stress gradient, (Col. 5 Lines 25-34).

The above quoted rejection is traversed for at least the following reasons:

First, the above-quoted rejection is improper in that it relies on portions of two different structures (e.g., the "substrate (Figure 3 #301)" and the "stress-balancing pad, (Figure 6 #638-1)". As indicated in the text copied below from Column 4 of Fork, these structures are clearly different in that Figs. 3(A) through 3(G) refer to a "first embodiment", and Figs. 6(A) through 6(H)) refer to a "third embodiment".

4

FIGS. 3(A) through 3(G) are cross-sectional side views illustrating a method for fabricating a spring structure according to a first embodiment of the present invention;

according to a second embodiment of the present invention;

FIGS. 6(A) through 6(H) are cross-sectional side views illustrating a method for fabricating a spring structure according to a third embodiment of the present invention;

4

As described in the embodiments provided below, self-alignment of the release material is beneficial both when the release material is electrically conductive, and when the release material is electrically non-conductive. Specifically, a first embodiment of the present invention utilizing a conductive release material is described below with reference to FIGS. 3(A) through 3(G), and a second embodiment of the present invention utilizing a non-conductive release material is described below with reference to FIGS. 5(A) through 5(G).

In addition, self-alignment can be achieved using several fabrication techniques. For example, a photoresist mask is utilized in the first and second embodiments (mentioned above) to etch both the spring metal and the release material. In a third embodiment, described with reference to FIGS. 6(A) through 6(H), this etching step is performed using plated metal as the spring metal mask.

Because the pending rejection relies on strutures from two separate embodiments, the rejection is clearly improper and should be withdrawn.

Second, as previously argued by Applicants, the pending rejection improperly mischaracterizes Fork's structure 638-1 as having a "second internal stress gradient". The common definition of "gradient" is a change in the value of a

quantity (e.g., temperature, pressure, or concentration) with change in a given variable and especially per unit distance in a specified direction. As used with reference to the present invention, the term "gradient" is related to a change in the internal stress with a change in film thickness. Referring again to Applicants' Fig. 4 (reproduced above), the positive internal stress gradient in anchor portion 122 increases from a minimum to a maximum value in the positive z-axis direction, and the negative internal stress gradient in stress-balancing pad 130 decreases from a maximum value to a minimum value in the positive z-axis direction. Applicants' specification further teaches that one method to generate these opposite internal stress gradients is to utilize fabrication parameters (e.g., deposition chamber pressure variations) that are altered in manner opposite to those used to form the spring metal layer/anchor portion:

> Spring metal finger 120 is etched from a stress-engineered metal film that is deposited by DC magnetron sputtering one or more metals using gas (e.g., Argon) pressure variations in the sputter environment during film growth. These pressure variations are controlled using known techniques to generate an internal stress gradient that causes claw 125 to bend away from substrate 101 when an underlying release material is removed. (Paragraph 0026, page 11, near top.)
>
> However, stress-balancing pad 130 is formed using a pressure variation sequence that is opposite to that utilized to generate spring metal finger 120, thereby causing stress-balancing pad 130 to include an internal stress that is opposite to that provided in spring metal finger 120. (Paragraph 0028, page 11, near bottom.)

In contrast, Fork teaches neither that plated metal portion 638-1 includes "an internal stress gradient", nor

that the "internal stress gradient" of plated metal portion 638-1 is opposite to the first internal stress gradient" provided in the anchor portion of the spring metal finger. As pointed out above, to generate "an internal stress gradient", a pressure variation sequence (or other stress varying procedure) must be utilized during the formation of plated metal portion 638-1. The text and figures of Fork that are relied upon by the Examiner fail to even remotely suggest either that plated metal portion 638-1 includes an internal stress gradient, or that a pressure variation sequence (or other stress varying procedure) is utilized in the formation of plated metal portion 638-1. Specifically, Fork's column 9, lines 62-63 (which are specifically relied upon by the Examiner) only mention the formation of plated metal portion 638-1 for improving electrical conductance:

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The resulting spring structure **600** is shown in FIG. **6**(H). Note that some of passivation metal portion **630-1** (or plating metal if no passivation metal is used) is optionally retained on spring metal finger **620-1**F to improve electrical conduction and/or improve contact resistance. In addition, portions **638-1** of the plated metal are retained on all spring metal that remains secured to the substrate, thereby improving electrical conductance. Note also that the side edges of anchor portion **622** (and underlying release material portion **612**) are self-aligned to plated material portion **638-1**.

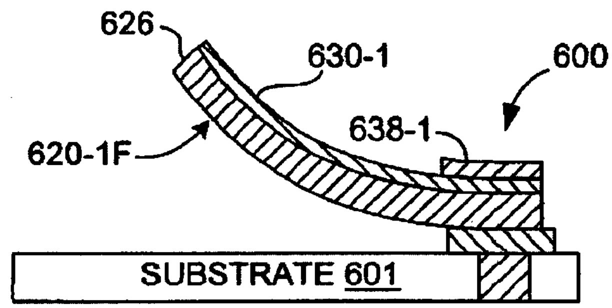

FIG 6(H)

Similarly, Fork's column 5, lines 25-34 merely discuss the formation of a spring metal layer 320, which corresponds to spring metal finger 620-1F of Fig. 6(H):

5

FIG. 3(B) shows a spring metal layer **320** formed on release material layer **310** using know processing techniques such that it includes internal stress variations in the growth direction. For example, in one embodiment, spring metal layer **320** is formed such that its lowermost portions (i.e., adjacent to release material layer **310**) has a higher internal tensile stress than an upper portion of spring metal layer **320**, thereby causing spring metal layer **320** to have internal stress variations that cause a spring metal finger to bend upward away from substrate **301** (discussed below). Methods for generating such internal stress variations in spring metal layer **320** are taught, for example, in U.S. Pat. No. 3,842,189 (depositing two metals having different internal stresses) and U.S. Pat. No. 5,613,861 (e.g., single metal sputtered while varying process parameters), both of which being incorporated herein by reference. In one embodiment, which utilizes a 100 nm Ti release material layer, spring metal layer **320** includes MoCr sputter deposited to a thickness of 3 microns. In other embodiments, an Mo spring metal layer can be formed on Si or Ti release material layers.

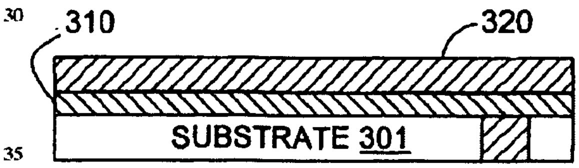

FIG 3(B)

The Final Office Action addressed Applicants' previous response by introducing a new basis for rejection that was not previously raised. The new argument is entered on page 2 of the pending Office Action, and is highlighted below:

> The Office Action filed in Paper No. 6 pointed out that the reference indicates that the metal spring consists of different gradients formed there in, (Fork et al. Col. 5 Lines 25-34), in which one of the gradients formed in the metal spring has a resulting vector away from the substrate. The Office Action also points out that the second gradient has a resulting vector the opposite of the first gradient, (Fork et al. Col. 9 Lines 62-63), in which the disclosure states the metal spring remains secure to the substrate. It is inherent by these disclosed statements in Fork et al. that the gradients would be the opposite otherwise the metal spring would pull away from the substrate, just as the first gradient area of the metal spring does as seen in Fork et al.'s Figure 3g. The 35 US.C 102(e) rejection will stand as is.

Applicant argued that the quoted text enclosed in the box (above) introduces new grounds for rejection because the

originally stated rejection of Claim 1 did not even remotely discuss the so-called "inherent" characteristics of plated metal portion 638-1. That is, as indicated above, the original rejection specifically argues that the plated metal portion 638-1 has a "second internal stress gradient". Applicants contend that the Examiner's reference to the "inherent" characteristics of plated metal portion 638-1 constitutes new grounds for rejection as directed to Claim 1, and as such the finality of the present Office Action is improper.

Even if the new rejection was properly entered in the Final Office Action, Applicants traverse the new rejection because the Examiner is clearly incorrect in his assertion that "the gradients would be the opposite otherwise the metal spring would pull away from the substrate". Applicants' specification clearly indicates, with reference to prior art structures, that the anchor portions of conventional spring metal fingers are secured to the underlying substrate, but that over time these connections can be weakened:

> A typical spring includes a spring metal finger having a flat anchor portion secured to a substrate, and a curved claw extending from the anchor portion and bending away from the substrate. (Paragraph 0002, page 1, mid-page.)
>
> The present inventors recognized that most failures of spring structures (e.g., separation of the spring structure from an underlying substrate through delamination or peeling) occur a significant amount of time after fabrication. The present inventors believe these failures are caused at least in part by the internal stress gradient retained in the anchor portion of the spring metal finger. That is, although the internal stress is essentially relieved in the claw of the spring metal finger upon release, the

> internal stress is retained in the anchor portion of the spring metal finger, along with other "trace" or unreleased portions of the spring metal layer. Over time, this retained internal stress is believed to bend the edges of the anchor portion upward (i.e., away from the underlying substrate), thereby causing delamination or peeling that weakens the attachment of the spring metal finger to the substrate. (Paragraph 3, page 2.)

The above-quoted text clearly indicates that prior art spring structures remained connected to an underlying substrate without the use of a stress-balancing pad. What this passage expresses, in other words, is that peeling does not occur until the stresses concentrated at the interfaces of the anchor portion can overcome the adhesion of the release layer to the substrate and/or spring. Within a regime of limited spring stiffness and compression, the adhesion is large enough to resist such stresses. It is fallacious to conclude that the anchor would pull away from the substrate without stress balancing layers, because this conclusion ignores the presence of interface adhesion. Stress balancing layers simply extend the regime of stiffness and compression that may be achieved.

Moreover, Fork in fact teaches away from the Examiner's apparent argument that a stress balancing layer is necessary in that Fork discloses spring structures that do not include the plated metal portion 638-1 (e.g., see Fork's Fig. 3(G) (reproduced below for reference):

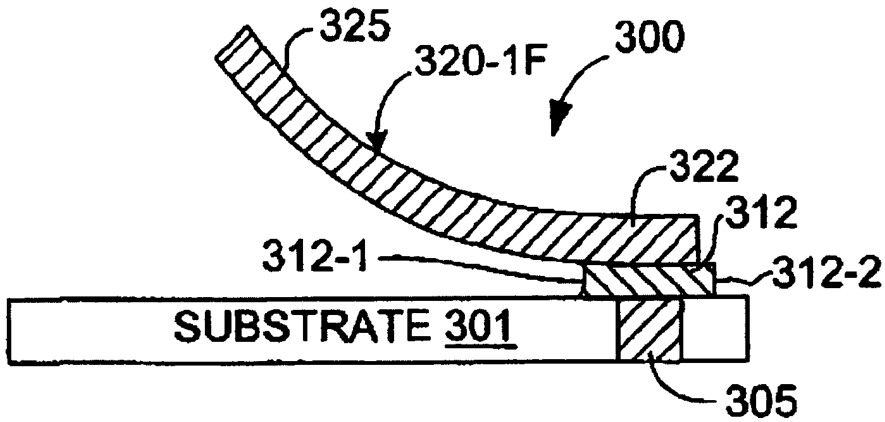

FIG 3(G)

Accordingly, the Examiner's assertion that it "is inherent by these disclosed statements in Fork et al. that the gradients would be the opposite otherwise the metal spring would pull away from the substrate" is not supported by Fork, and therefore should be withdrawn.

For at least the above reasons, Applicants contend that the rejection of Claim 1 is improper and should be withdrawn.

B. Claim 2 is patentable under 35 U.S.C. 102(e) over Fork

Claim 2 is dependent from Claim 1, and is therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 1.

In addition, Claim 2 further recites:

> ...wherein the second internal stress gradient of the stress-balancing pad is equal in magnitude to or greater in magnitude than the first internal stress gradient of the anchor portion.

In rejecting Claim 2, the Examiner writes:

> Referring to claim 2, a spring structure, wherein the second internal stress gradient of the stress-balancing pad is equal in magnitude to or greater in magnitude, (Col. 9 Lines 62-63, where the stress-balancing pad is secured to the

> substrate and has the opposite stress gradient than the spring metal finger and it is apparent that the magnitude of the stress gradient for the stress balancing pad is equal or greater than the first internal gradient because the spring metal finger would peel away from the substrate if it was less than; this can be seen in Figure 6), than the first internal stress gradient of the anchor portion, (Col. 5 Lines 25-34).

Applicants traverse the rejection of Claim 2 for reasons similar to those directed to the "new grounds of rejection" discussed above with reference to Claim 1. In particular, Applicants' specification clearly indicates, with reference to prior art structures, that the anchor portions of conventional spring metal fingers are secured to the underlying substrate, but that over time these connections can be weakened (see paragraphs 0002 and 0003 of Applicants' specification, reproduced above). What this text expresses is that peeling does not occur until the stresses concentrated at the interfaces of the anchor portion can overcome the adhesion of the release layer to the substrate and/or spring. Within a regime of limited spring stiffness and compression, the adhesion is large enough to resist such stresses. It is fallacious to conclude that the anchor would pull away from the substrate without stress balancing layers, because this conclusion ignores the presence of interface adhesion. Stress balancing layers simply extend the regime of stiffness and compression that may be achieved. Moreover, as set forth above in additional detail, Fork in fact teaches away from the Examiner's apparent argument that a stress balancing layer is necessary in that Fork discloses spring structures that do not include the plated metal portion 638-1 (e.g., see Fork's Fig. 3(G)). For at least the above reasons, the Examiner's assertion that it "it is apparent that the magnitude of the stress gradient for the stress balancing pad is equal or greater than the first internal

gradient because the spring metal finger would peel away from the substrate if it was less than" is not supported by Fork.

For at least the above reasons, Applicants contend that the rejection of Claim 1 is improper and should be withdrawn.

C. Claims 3-7 are patentable under 35 U.S.C. 102(e) over Fork

Claim 3

Claim 3 is also dependent from Claim 1, and is therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 1.

In addition, Claim 3 further recites:

> ...wherein both the spring metal finger and the stress-balancing pad consist essentially of a single material composition.

In rejecting Claim 3 the Examiner writes:

> Referring to claim 3, a spring structure, wherein both the spring metal finger and the stress-balancing pad, (Figure 6 #638-1), consist essentially of a single material composition, (Col. 5 Line 42 states the spring metal finger #320 can be made of MoCr and Col. 10 Line 8 states the stress balancing pad #638-1 can be made of MoCr).

Applicants traverse the rejection directed to Claim 3 in that it mischaracterizes the teachings of Fork's Column 10, line 8. The Examiner argues "Col. 10 Line 8 states the stress balancing pad #638-1 can be made of MoCr". As clearly set forth in Col. 9, lines 11-38 and 47-67 (reproduced below), the "stress metal layer" referred to Col. 10, line 8 (also shown) is stress metal layer 620, NOT plated layer 638:

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The fabrication method according to the third embodiment begins in a manner similar to the first and second embodiments (discussed above) in that a release material layer **610** is formed over a substrate **601** that includes a contact pad **605** (FIG. **6**(A)), and then a spring metal layer **620** is formed on release material layer **610** (FIG. **6**(B)). Release material layer **610** can be conductive, as described above with reference to the first embodiment, or non-conductive, as described above with reference to the second embodiment. The present example depicts the use of conductive release materials are used—if non-conductive release materials are used, a metal strap must be included that is formed in the manner described above with reference to FIGS. **5**(D) and **5**(E).

Plated metal is then patterned on spring metal layer **620** as follows. First, an optional passivation metal layer **630** is deposited on spring metal layer **620** (FIG. **6**(C)). Passivation metal layer **630** (e.g., Au, Pt, Pd, or Rh) is provided as a seed material for the subsequent plating process if spring metal layer **620** does not serve as a good base metal. Passivation metal layer **630** may also be provided to improve contact resistance in the completed spring structure. Next, a resist pattern (mask) **635** is formed over spring metal layer **620** (i.e., on passivation metal layer **630**, if used) that has an opening **636** whose edge **637** is in the shape of the spring metal island to be formed (FIG. **6**(D)). A plated metal pattern **638**, such as nickel, is then formed using a known plating process through opening **636** on the exposed portion of passivation metal layer **630** (FIG. **6**(E)). Plated metal structure **638** may comprise more than one type of metal. The plating process can be electroless, but is preferably electroplating, using the previously deposited metal (i.e., passivation metal layer **630** and/or spring metal layer **620**) as the cathode. Resist pattern **635** is then removed.

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Referring to FIG. **6**(G), once etching is completed, a release mask **650** is applied in the manner described in the above embodiments. During the subsequent release etch, all or part of plated metal structure **638** exposed within the release window is selectively etched using a suitable etchant **660-A** that does not remove free portion **622** of spring metal island **620-1**. Release material portion **615** is also removed using an etchant **660-B**, which either can be the same as or different from etchant **660-A**. If desired, the release window can then be stripped, or may be retained as passivation. The latter may be preferred if it is a material such as polyimide.

The resulting spring structure **600** is shown in FIG. **6**(H). Note that some of passivation metal portion **630-1** (or plating metal if no passivation metal is used) is optionally retained on spring metal finger **620-1F** to improve electrical conduction and/or improve contact resistance. In addition, portions **638-1** of the plated metal are retained on all spring metal that remains secured to the substrate, thereby improving electrical conductance. Note also that the side edges of anchor portion **622** (and underlying release material portion **612**) are self-aligned to plated material portion **638-1**.

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The choice of plating material is dependent on its selective etchability compared to spring metal island. However, because the thickness of the plated metal pattern (a few microns) would be much greater compared to the spring metal layer (less than 2 microns), any etching that might occur on the plated metal pattern would be negligible. An example that is possible using selective etchants is a plated Ni pattern on a Au/MoCr/Ti spring metal layer. In this embodiment, examples of wet etchants that can be used are: NaOH-KFCN for the MoCr, KI for the Au, HF for the Ti, and HCl for the final removal of the Ni.

In particular, the text of Col. 9 provided above clearly teaches the formation of a stress metal layer 620, a passivation layer 630 formed over stress metal layer 620, and then plated metal pattern 638, which is subsequently etched to form plated metal portion 638-1. Note that Col. 10, lines 1-8 refer to the plating material and associated etchant, and specifically to an etchant for etching Ni formed on "a Au/MoCr/Ti spring metal layer". Accordingly, the Examiner's contention that plated metal portion 638-1 is formed from MoCr is clearly not supported by the cited passage from Fork.

Accordingly, the specific rejections directed to Claim 3 is improper and should be withdrawn.

Claims 4-7

Claims 4-7 are dependent from Claim 3, and are therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 3.

In addition, the rejections of Claim 5-7 are further traversed in that they relies on a rejection under 35 U.S.C. 112 that is no longer pending. For example, the pending rejection of Claim 5 is as follows:

> 8. Referring to claim 5, a spring structure, further comprising an etch stop layer formed between the anchor portion of the spring metal finger and the stress-balancing pad, (See 112 rejection above).

Applicant respectfully points out that there is no pending rejection under 35 U.S.C. 112. Similar references to the non-existent rejection under 35 U.S.C. 112 are referenced in the specific rejections directed to Claims 6 and 7. As such, the rejections of Claims 5-7 are clearly improper and must be withdrawn.

For at least the above reasons, Applicants contend that the rejections of Claims 3-7 are improper and should be withdrawn.

D. Claims 8, 9, 11-15 are patentable under 35 U.S.C. 102(e) over Fork

Claims 8, 9, 11-15 and 17 are dependent from Claim 1, and are therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 1.

In addition, Applicants traverse the rejections of Claims 9 and 13-15 for reasons similar to those provided

above with reference to Claim 3. In particular, Col. 9, lines 11-38 and 47-67 (reproduced above) clearly teach that the "stress metal layer" referred to Col. 10, line 8 is stress metal layer 620, NOT plated layer 638. As such, the Examiner's contention that plated metal portion 638-1 is formed from MoCr is clearly not supported by Fork's Col. 10, line 8. Accordingly, the specific rejections directed to Claims 9 and 13-15 are improper and should be withdrawn.

E. <u>Claims 18 is patentable under 35 U.S.C. 102(e) over Fork</u>

Similar to Claim 1, Claim 18 recites (in pertinent part):

> ...a spring metal finger having an anchor portion supported by the substrate and a claw portion extending over the substrate; and
> a stress-balancing pad formed over the anchor portion of the spring metal finger,
> wherein the spring metal finger is formed from a first stress-engineered material having a first internal stress moment that causes the claw portion to bend away from the substrate, and
> wherein the stress-balancing pad is formed from a second stress-engineered material having a second internal moment that opposes to the first internal stress moment.

In rejecting Claim 18, the Examiner argues (in part):

> ...wherein the spring metal finger, (Figure 6 #620), is formed from a first stress-engineered material having a first internal stress moment that causes the claw portion to bend away from the substrate, (Figure 6 #60 1), and wherein the stress-balancing pad is formed from a second stress-engineered material having a second internal moment that opposes to the first internal stress moment, (Col. 9 Lines 62-63, where the stress-balancing pad is secured to the

> substrate and has the opposite stress gradient than the spring metal finger, which the spring metal finger pulls away from the substrate and can be seen in Figure 6).

The above-quoted rejection is traversed for reasons similar to those provided above with reference to Claim 1. In particular, the rejection is traversed in that Fork teaches neither that plated metal portion 638-1 includes "a second internal momement", nor that the "second internal moment" of plated metal portion 638-1 is opposed to the "first internal stress moment" of the spring metal finger. Similar to the arguments related to internal stress gradients, to generate "an internal moment", a pressure variation sequence (or other stress varying procedure) must be utilized during the formation of plated metal portion 638-1. The text and figures of Fork that are relied upon by the Examiner fail to even remotely suggest either that plated metal portion 638-1 includes an internal moment, or that a pressure variation sequence (or other stress varying procedure) is utilized in the formation of plated metal portion 638-1. Accordingly, the rejection of Claim 18 under 35 U.S.C. 102(e) is improper and should be withdrawn.

F. Claims 19 is patentable under 35 U.S.C. 102(e) over Fork

Claim 19 is also dependent from Claim 18, and is therefore believed to be patentable over Fork for at least the same reasons as those set forth with respect to Claim 18.

In addition, similar to Claim 2, Claim 19 further recites:

> ...wherein the first internal stress moment of the anchor portion has a first magnitude, and
>
> wherein the second internal stress moment of the stress-balancing pad has a second magnitude that is equal to or greater than the first magnitude.

Accordingly, for reasons similar to those provided above with reference to Claim 2, Claim 19 is further distinguished over Fork, and the rejection of Claim 19 should be withdraw.

IX. CONCLUSION

For the foregoing reasons, it is submitted that the Examiner's rejections of Claims 1-19 are erroneous, and reversal of these rejections is respectfully requested.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Services as First Class Mail in an envelope addressed to: Mail Stop Appeal Brief-Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA, 22313-1450.

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Attorney for Appellant

Dec. 29, 2003

Date of Signature

X. APPENDIX A

1. A spring structure comprising:

a substrate;

a spring metal finger including an unlifted anchor portion attached to the substrate and a released claw portion extending over the substrate, wherein the anchor portion has a first internal stress gradient; and

a stress-balancing pad formed on the anchor portion of the spring metal finger, wherein the stress-balancing pad has a second internal stress gradient that is opposite to the first internal stress gradient.

2. The spring structure according to Claim 1, wherein the second internal stress gradient of the stress-balancing pad is equal in magnitude to or greater in magnitude than the first internal stress gradient of the anchor portion.

3. The spring structure according to Claim 1, wherein both the spring metal finger and the stress-balancing pad consist essentially of a single material composition.

4. The spring structure according to Claim 3, wherein the single material composition is one of Molybdenum (Mo) and Molybdenum-Chromium (MoCr).

5. The spring structure according to Claim 3, further comprising an etch stop layer formed between the anchor portion of the spring metal finger and the stress-balancing pad.

6. The spring structure according to Claim 5, wherein both the spring metal finger and the stress-balancing pad

consist essentially of Molybdenum (Mo), and wherein the etch stop layer comprises Chromium (Cr).

7. The spring structure according to Claim 5, wherein both the spring metal finger and the stress-balancing pad consist essentially of Molybdenum-Chromium (MoCr), and wherein the etch stop layer comprises Titanium (Ti).

8. The spring structure according to Claim 1, wherein the spring metal finger comprises a first material, and wherein the stress-balancing pad comprises a second material that is different from the first material.

9. The spring structure according to Claim 8, wherein the first material consists essentially of a Molybdenum-Chromium alloy (MoCr), and wherein the stress-balancing pad consists essentially of Molybdenum (Mo).

10. The spring structure according to Claim 8, wherein the first material consists essentially of Nickel-Zirconium (NiZr), and wherein the second material consists essentially of Titanium that is solution hardened with Silicon (Ti:Si).

11. The spring structure according to Claim 1, further comprising a support pad formed between the substrate and the anchor portion of the spring metal finger.

12. The spring structure according to Claim 11, wherein the support pad comprises one of Titanium (Ti) and Silicon (Si).

13. The spring structure according to Claim 11, wherein the support pad comprises Ti, wherein both the spring metal

finger and the stress-balance portion comprise Molybdenum (Mo), and wherein the spring structure further comprises an etch stop layer consisting of Chromium (Cr) that is formed between the spring metal finger and the stress-balance portion.

14. The spring structure according to Claim 11, wherein the support pad comprises Si, wherein both the spring metal finger and the stress-balance portion comprise Molybdenum-Chromium (MoCr), and wherein the spring structure further comprises an etch stop layer consisting of Titanium (Ti) formed between the spring metal finger and the stress-balance portion.

15. The spring structure according to Claim 11, wherein the support pad comprises Titanium (Ti), wherein the spring metal finger comprises Molybdenum-Chromium (MoCr), and wherein the stress-balance portion comprise Molybdenum (Mo).

16. The spring structure according to Claim 11, wherein the support pad comprises Ti, wherein the spring metal finger comprises Nickel-Zirconium (NiZr), and wherein the stress-balance portion comprises Titanium that is solution hardened with Silicon (Ti:Si).

17. The spring structure according to Claim 11, further comprising a conductor formed on the substrate,

wherein the support pad comprises an electrically conductive material, and

wherein the spring metal finger is electrically connected to the conductor via the support pad.

18. A spring structure comprising:

a substrate;

a spring metal finger having an anchor portion supported by the substrate and a claw portion extending over the substrate; and

a stress-balancing pad formed over the anchor portion of the spring metal finger,

wherein the spring metal finger is formed from a first stress-engineered material having a first internal stress moment that causes the claw portion to bend away from the substrate, and

wherein the stress-balancing pad is formed from a second stress-engineered material having a second internal moment that opposes to the first internal stress moment.

19. The spring structure according to Claim 18,

wherein the first internal stress moment of the anchor portion has a first magnitude, and

wherein the second internal stress moment of the stress-balancing pad has a second magnitude that is equal to or greater than the first magnitude.